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Editor :
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PROFESSOR J. McCUNN, M.R.C.V.S., M.R.C.S., L.R.C.P.,
Professor of Anatomy, The Royal Veterinary College

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EDITORIAL

BOVINE INFERTILITY

It has been shown from several sources that infertility is one of the important limiting factors in the breeding of cattle, especially dairy stock, and that if breeding disorders can be corrected the losses associated with lower milk and calf yields can be eliminated to a considerable extent. Infertility is probably largely of a temporary character. Research work during the past few years has increased our knowledge of the causes and of the methods of treating affected cattle, with the result that veterinary surgeons are playing a useful part in controlling the breeding in herds throughout the country. Attention has been focused recently on trichomoniasis as a cause of infertility, and it may be that infection with *Trichomonas fœtus* is more prevalent than is generally believed. Some months ago we published an important article on the subject, in which was included a description of the infection in a herd and in which the insidious nature of the disease was clearly demonstrated. In this number of The Veterinary Journal is published an article in which it is shown that the bull might be *actively* infected with the parasite. In all probability the bull acts, in the main, as a mechanical carrier of the infection from cow to cow: the present article shows that, in addition, the bull may actually become infected. It is important, therefore, in dealing with trichomoniasis as a cause of infertility in a herd to realise that such an infection in the bull might exist.

Attention is being directed to artificial insemination as a means of increasing the quality of dairy stock by ensuring that the semen of specially selected bulls

will be used in the begetting of suitable calves. There is much to be said for the practice of artificial insemination on a greater scale than at present carried out, but consideration must be given to a variety of important points before any large-scale use of the method is brought into operation throughout the country. Doubtless those who are in close touch with the work will be able to advise on all the necessary precautions to be taken and on the limitations of the method. Apart from an improvement in stock which may result from the practice of artificial insemination of cattle, its adoption should tend to diminish the risk of spreading disease in herds where there is infection of the genital tract of the cows. From the health point of view, therefore, there is much to be said for the introduction of artificial insemination in special cases. In selecting bulls from which semen is to be collected, it is essential to ensure that the animals are themselves free from any disease which could be conveyed from them to the inseminated females. Clinical examination of the bull may go far to prove freedom from infection. It seems to us, however, that some difficulty may be experienced in arriving at a conclusion that all risk of conveying trichomonads has been overcome. If actual infection occurred in every bull carrying trichomonads a very careful examination of the genital organs might result in diagnosing the infection. It would appear, however, that infection with resultant lesions in the genital tract may be difficult to diagnose and attention must therefore be directed to the methods of diagnosis of the "carrier" bull. Further work would appear to be necessary on this important subject when such points as the conditions under which the parasite continues to remain alive in the genital tract of the bull are studied and methods are sought to prove non-infectivity. At the moment, probably the most satisfactory method of ascertaining that a bull is not conveying infection is by an examination of the cows and heifers served by him over a period, the agglutination test being used in a number of the animals, if other methods do not appear to be satisfactory.

General Articles

TRICHOMONIASIS IN THE BULL

By W. R. KERR,
Veterinary Research Division, Ministry of Agriculture, Northern Ireland

It is generally accepted that infective sterility in bovines associated with the protozoan *Trichomonas fœtus* is venereal in character and that the infection is spread to and by the bull at coitus. Andrews and Miller (1936) and Kust (1936) suggest that other means of infection exist in view of their claim to have found trichomonad infection in virgin heifers. In direct microscopical examinations of copious vaginal discharges from nine virgin heifers encountered in herds in which trichomonas infection was active, I failed to demonstrate the presence of *Trichomonas fœtus*. Clinical evidence indicates that the bull is directly involved and must, therefore, be regarded as the pivot of infection in an outbreak. With this fact in mind it is essential to appreciate fully the actual degree and frequency with which the bull becomes infected. Definite clinical symptoms may be shown in some cases, for example, in " lazy service," but other affected bulls may show no symptoms and still act as carriers of the infection. It is essential to appreciate the part played by the bull in the cycle of events before suitable control and curative measures against trichomonad fœtus can be employed.

Clinical History

Under field conditions many difficulties arise in collecting evidence of infection in the bull and in many instances the ultimate diagnosis of infection of cows served by him has to depend on the findings of *Trichomonas fœtus* in cows in a herd. It is common to find that many outbreaks have existed for some time before attention has been drawn to them by the local veterinary surgeon or the agricultural adviser, and during this time the farmer has blamed the bull and disposed of him. The evidence that remains is the material symptoms amongst the cows and a verbal history of the behaviour of the bull. Moreover, few farms maintain a satisfactory stock record. Therefore the history of œstrum, matings and abortions is unreliable, and here again conclusions have to be drawn from history as given by the owner. In this type of case the testing of suspect cows by means of the agglutination test has been found to be of great value in assisting diagnosis.

In Northern Ireland the large self-contained farm with its stock of cows and a bull is not frequently met with, as the province is essentially one of small holdings with an average of 4.7 cows per holding. This necessitates the use of the communal bull and as many as twenty holdings may depend upon the services of one bull. Therefore, at the outset there exist two groups of interested persons —the farmer owning the communal bull and the farmer possessing only cows, and their reactions to an outbreak of infective sterility are somewhat different. The bull owner is unable to keep a careful check upon the health of visiting cows, more especially recently-purchased cows. He may be unable to appreciate fully the significance of cows returning to the bull or of early abortions, and still allow the bull to carry out matings of other cows. This tends to bring about the spread of infection throughout the holdings.

XUM

The cow owner, finding that his cows are not settling to that particular bull, sends his cows to other bulls in the immediate district, and as many as six bulls are known to have been infected in this way. Thus a vicious cycle is set up, the different centres of infection fusing to create an extensive outbreak of infective sterility. The cows, after months of sterility, and in the end failing to conceive, are sold as fat or as " strippers."

The veterinary practitioner has failed in the past to diagnose trichomoniasis with sufficient certainty to institute satisfactory measures of control. The farmer, left to his own resources, adopted such measures as had been suggested by his past experience in order to reduce his loss. One of the methods which gained reasonable success was to cease breeding for six months, dispose of the bull and fatten off badly affected cows before starting afresh.

In spite of the fact that many of the outbreaks died out without professional assistance and that some others were successfully treated by the local practitioner, twenty-six centres of infection were referred to the Ministry's laboratory for investigation. The expression " centres of infection " is used to denote not so much an outbreak in one farm but rather one involving a collection of farms with a communal bull. The twenty-six centres involved over thirty bulls but on account of the difficulties already described of getting a complete history, only detailed clinical evidence concerning five bulls was obtained. The remainder had either been disposed of or their history was too vague or contradictory to be of scientific value for a precise story of the symptoms of the disease in the bull.

In analysing the clinical evidence against the bull a wide range of symptoms is recognised, but these are not necessarily always related to the virulence of the attack amongst the cows. In a field case with a history of a high degree of sterility and of abortions amongst the cows, the bull may show little or no symptoms of trichomonas infection. Here the possibility is accepted of an acute phase which may not have been noticed by the farmer. The reverse also holds good in that the symptoms in the cow may be mild or of moderate nature, yet the symptoms in the bull may be severe. In one of the author's experiments this occurred (see Bull "A").

Literature of Symptoms

To the best of our knowledge there is little evidence in the literature relating to detailed observation of the symptoms and the course of the disease in the bull, and we rely on Kust (1933 and 1935), Andrews and Miller (1938), Swangard (1941) and Abelein (1941) for the data. Many other workers describe the treatment of the disease in the bull with additional notes on incidental symptoms.

Swangard (1941) does not believe that trichomonads invade the mucosa or the uro-genital tract and that they prefer only the stratified squamous epithelium of the preputial mucosa.

Abelein (1941) suggests that there is no evidence that trichomonads, isolated from the urethra, the semen, and the blood of infected animals, were *Trichomonas fœtus* and that investigations putting forward such claims failed to differentiate between *Trichomonas fœtus* with its three anterior flagella and other species with four anterior flagella. He also states that specimens of blood, urine and semen collected by himself from 128 infected bulls revealed, in only one case, and that in the urine, the presence of trichomonads. On this evidence he believes that the

organisms may invade the urethra temporarily but do not establish themselves in that organ. In no case was a blood infection detected by him.

Kust (1933) records the artificial infection in a bull by the inoculation into the sheath of exudate from a case of pyometra in a cow in which numerous trichomonads were present. The penis showed reddened nodules and trichomonads were detected in secretion found in the folds of the prepuce. After partial recovery the bull was allowed to serve a healthy cow. Five hours after service the vulva commenced to swell, the mucous membrane was reddened and a muco-purulent exudate appeared. On the third day trichomonads were observed in the exudate. The cow aborted sixteen weeks later and trichomonads were present in the fœtus, placental membranes, and in the amniotic fluid. Later, the sheath of the bull was washed out with normal saline, the lesions caused by trichomonads disappeared and the bull later served cows with normal results.

Kust (1935) draws attention to bulls which have passed the acute stage of the disease and exhibit no clinical symptoms, but which may still harbour the parasite in the preputial secretion, bladder, urethra, testicle and seminal duct, and pass the organism in the semen and still be infective to cows. He also states that an infection of this kind sets up only a chronic endometritis and a sterility in cows which is more difficult to treat than the usual acute form of the disease.

In view of this evidence the following observations are of interest. They deal with three bulls, the symptoms of which, in many points, agree with those described by Kust.

History and Symptoms of Individual Bulls

Bull "A."—An experimentally infected bull used in the group experiment A.

The following method was adopted to infect the bull artificially with a washed suspension of a culture of *Trichomonas fœtus,* strain Belfast. The animals was cast and placed in the dorsal position. The suspension was slowly injected into the sheath and allowed to percolate into the membranes, assisted by gentle massage.

Twenty-four hours later he mated heifers A8 and C4.

Three days later he mated heifer A3.

Four days later he mated heifer A2.

The subsequent history of these heifers is described elsewhere. A3 and C4 were positively infected but in neither of these animals was swelling of the vulva noted within the first twelve hours following service, as recorded by Kust in his experiment; but it is noted that one essential point of difference existed between the two experiments, in that he used pyometra discharge, rich in trichomonads, to infect the bull while in the case of bull "A" a washed culture was used.

No distinct changes appeared in the genitals until the sixteenth day, when the bull experienced difficulty in remating A5 and C10. Extrusion of the penis caused pain, with the result that, at first, he had no desire to complete coitus, but thirty minutes later he finally completed the service. This is the typical " lazy service " described by Kust and Abelein, which has been observed in many field cases in Northern Ireland.

The penis, on examination, following epidural anæsthesia showed a grey catarrhal condition of the mucous membrane and areas of petechial hæmorrhage.

XUM

Fourteen days later the mating of A11 occupied one hour before it was completed. Following this service he was quite unfit for further use.

The physical condition of the bull at this stage was quite good and he was sexually keen to mate the female, until he attempted to extrude the penis, when sexual desire apparently ceased. In several minutes this cycle would recommence and end with the same result without completion of service.

At this stage it was noted that, although he had control of micturition, there was pain in passing urine, and noticeably with the first flow. The first sign of desire to urinate was a restlessness, evinced by a paddling action of his hind feet, which became accentuated until the first flow had commenced. It was also noted that it was some time before flow ceased, as he tended to dribble and seemed unable to terminate the flow. Careful observation was made daily in view of the risk of stricture.

The second examination under epidural anæsthesia was made ten weeks following infection. The condition of the mucosæ of the penis had altered from the grey catarrhal with pin-point hæmorrhages to that appearing in the vagina of infected cows. Islands of granular tissue were observed at the base of the penis and at the involution of the preputial sheath. These islands, as were found later, were composed of proliferations of surface lymphatics. Around each island of granular tissue a zone of inflammation giving the appearance of a halo were present. A few relatively inactive trichomonads were noted in the secretion of the mucosæ. An attempt was made to treat the bull at this stage. An account of the treatment is given later.

Five months after infection acute orchitis developed. The difficulty evinced at micturition had increased without any sign of a definite stricture. The testes had enlarged to twice their normal size and were painful on palpation. The skin covering the scrotum was reddened. As the bull was losing condition rapidly it was decided to slaughter him and to carry out a complete post-mortem examination of his genitals.

Post-Mortem Results

1. *Testes.* Examination showed that the epididymis was the part chiefly involved; it was greatly enlarged, and contained what appeared to be an abscess about the size of a pigeon's egg, the contents of which were rich in lymphocytes, well formed, numerous and active spermatozoa and well-defined trichomonads. The trichomonads were regular in shape, oval, large and fairly active, with degenerate forms absent. An average of seven trichomonads per field were seen when using a low power lens in the examination of the wet films.

Cultures were made after searing the part and taking the usual sterile precautions. Chocolate blood plates, Loeffler serum slopes, trypsin agar slopes and trypsin broth tubes were used. On incubation a pure culture of a diphtheroid organism was obtained on the chocolate blood plates and serum slopes; no growth occurred on the trypsin agar or broth. The serum slopes were not liquefied. Sections were retained for examination.

2. *Uro-genital tract.* Two areas of a well-marked urethritis were present.

(a) The first area was found to commence about six inches from the free end of the urethra and to extend along the tract for some five inches. The urethra in this area was acutely inflamed.

(b) The second and more acutely inflamed area was found at the curvature of the ischial arch and its descent into the epididymis. The tissue here, more particularly the underlying tissue, was involved and the condition of this area suggested that it was of longer standing than the first area and that it was the probable cause of the difficulties at micturition. The remainder of the tract was apparently normal. Trichomonads were demonstrated throughout the tract.

(c) *Preputial Sheath and Penis.* The mucosa still retained the chronic pathological characters already described, but a further lesion was present at the juncture of the mucous membrane of the sheath and the skin, consisting of a ridge of small ulcers. Abelein (1941) describes areas of necrosis in treated parts of the sheath but believes them to be due to the use of acriflavine ointment 0.5 per cent. used in treatment. In our case it is not definite that these necrotic areas are in any way associated with the trichomonas parasite. They may be due to secondary bacterial infection or to the result of treatment tried with an 0.1 per cent. brilliant green irrigant.

Pathological Examination of Sections

1. *Epididymis.*

An article describing the histological findings in the various tissues is in the course of preparation and will be published later.

2. *Uro-genital tract.* The sections show a well-marked septic urethritis.

The mucosa of the urethra is the seat of fibrinous exudate on its surface and shows a cellular infiltration mainly of polymorphs in the submucosa. It has the appearance of a recent acute inflammatory reaction—an acute urethritis, such as would be associated with a bacterial infection of the urethra.

Summary of Bull "A"

Following an artificial infection by a washed suspension of a culture of *Trichomonas fœtus* a positive case of trichomonad infection developed, characterised by:

(a) A positively transmitted coital infection to heifers A2 and C4.
(b) The presence of a typical "lazy service" which ended in service failure.
(c) Symptoms of difficulty in micturition.
(d) Pathological changes in the penis and preputial sheath generally associated with trichomonad infections.
(e) Pathological changes in the urethra and in the testes.
(f) The presence of *Trichomonas fœtus* in the urethral tract, preputial sheath and in the epididymis five months subsequent to that infection.
(g) The presence of a secondary bacterial infection in the abscess condition of the epididymis.

Discussion of the Secondary Bacterial Infection

The presence of the diphtheroid infection in this animal has to be considered. The culture of trichomonas used had been under cultivation for two years and was not quite bacterially sterile. The contaminating organism was a diphtheroid but did not have the characters of *C. pyogenes.*

The bull's serum and that of the heifers and of the cow C4 served by him

were kindly tested by Dr. Lovell for *C. pyogenes* antitoxin content. This group of animals includes the two heifers successfully infected with trichomonas by service from the bull.

The serum of bull "A" was tested against the antitoxin of *C. pyogenes* just before he was slaughtered, and the titre was 150 "x" units per c.c., which Dr. Lovell considers to be on the high side of normality but not definitely indicative of an active *C. pyogenes* infection.

This bull did not transmit *C. pyogenes* as an active infection to the heifers, as their titres were, in every case, extremely low, ranging between 2—10 "x" units per c.c. The cow C4 had also a very low titre for an animal of about five years old, being 19 "x" units per c.c. (Lovell, 1939.)

It is particularly interesting to note that the two animals A2 and C4, which had been successfully infected by this bull with trichomonas, did not show enhanced titres of *C. pyogenes* antitoxin.

The abscess in the bull's epididymis may have been caused by the diphtheroid contaminating the trichomonas culture, but it must also be remembered that the ejaculate from bulls is not bacteria free.

Gunsalus, Salisburn and Willet (1941), made a bacterial count of forty-three ejaculations collected from nineteen bulls by means of an artificial vagina, and these ranged from 1,000 to 22 millions per m.l.

The predominating organisms were *Pseudomonas pyocanea, Bacterium coli,* Staphylococci and Diphtheroids. These findings are of interest as an indication of the possibility of bacterial contamination of the ejaculate, apart altogether from the possibility of contamination with the bacterial flora of the vagina and those introduced from the external orifice at time of service. This contamination as a potential source of secondary invaders must be taken into account where a trichomonad infection is involved. It is worth formulating that diphtheroids and other bacteria may be the cause of pathological changes with different tissues, whilst the trichomonad may be merely the vehicle carrying these secondary invaders.

Clearly it must always be borne in mind that wherever triochomonas penetrates and establishes itself bacteria will be liable to follow.

Bull "M."—From a natural outbreak involving cows in nine small holdings.

Positive cases were diagnosed in cows from each of these farms by direct examination. The degree of virulence was acute and characterised by sterility and several early abortions. A reliable history of the bull could not be got but there was evidence that he had been affected for approximately twelve months and that he had lost his keenness to mate cows. Post-mortem examination of this bull showed the presence of the characteristic grey catarrhal condition of the mucous membrane of the penis with the presence of islands of granular inflammatory tissue.

Trichomonads were found in the secretions of the sheath. Trichomonads were also demonstrated for some eighteen inches along the uro-genital tract. In this case the testes were not examined at post-mortem examination.

The point of interest in this bull is that trichomonads were found in the uro-genital tract proper. The examination of the urethra was carried out in such a way as to preclude the possibility of carried infection from the prepuce, but

that does not eliminate the possibility of shock invasion of the urethra by the trichomonads at time of slaughter.

Bull "E."—A valuable shorthorn bull in a herd of pedigree shorthorns.

The owner had allowed several cows from outside farms to be mated by this bull. One of these cows was alleged to have introduced the infection. It was stated that she passed a certain amount of white discharge following a service. Six months later the history of trichomonad infection was evident in the herd. Briefly, the position of the herd at the time of investigation was:

Of the seventeen cows in the herd only one was guaranteed to be in calf and holding to the first service.

Four cows had aborted between the fifth and eighth months.

Twelve cows had returned to two or more services.

Eleven out of twenty-three heifers mated by this bull were exhibiting a white discharge.

The herd was tested twice for the presence of agglutinins to *Brucella abortus* with negative results. Two of the four cows aborted a mummified fœtus and *Corynebacterium ovis* was isolated from one of these. *Trichomonas fœtus* was demonstrated by direct examination from all four cows which aborted.

The point of interest in this history of a virulent outbreak of *Trichomonas fœtus* associated with a Corynebacterium infection is the long period of infectivity in the bull. Owing to its high monetary value it was decided to treat him according to the usual practice, to be followed by a rest period of six months. His agglutination index to *Trichomonas fœtus* at the time of investigation was 12½/8, a definitely above normal reaction but not quite a positive as compared with our standard in reacting cows. (Kerr and Robertson, 1941.)

Three months after treatment the index was 13/9, giving a ratio similar to the first test. Six months after treatment the index figure was 13/9½.

The bull at no time exhibited clinical symptoms and his services had always been carried out satisfactorily. Therefore, at the end of the six months following treatment it was decided to make a test by allowing him to mate a virgin non-pedigree heifer. Two days following service this heifer passed a quantity of whitish-yellow, flaky discharge. At the peak of the outbreak amongst the cows in this herd this particular type of discharge had been observed by the farmer and its presence in this heifer was regarded as evidence that the infective agent was still active. This bull was then disposed of for beef, but owing to difficulties over which we had no control we were unable to make a post-mortem examination of this animal.

Finally, the iodine treatment was applied to the remaining cows in the herd. Later, they all conceived and calved normally in the following year.

Discussion of Various Points in Relation to the Bull

In addition to the difficulties of obtaining first-hand evidence concerning the symptoms in the bull, the difficulty of direct examination has to be taken into account. A straightforward examination by the veterinary surgeon of the bull's genitals, employing the normal methods of physical restraint, is not easy, unless epidural anæsthesia is employed. In this connection, Abelein (1941) recommends the passing of a brush through a canula into the preputial sac and obtaining material for examination. Of two hundred and eighty-one bulls examined he

found one hundred and thirty-four positive by this method. Nevertheless, difficulty and danger exist in making such examinations, as many types of bulls are definitely intractable.

The method advocated when epidural anæsthesia is complete is to pass a bandage loop around the penis and draw it out gently. An examination of the penis and mucous membrane of the sheath can then be made. The presence of pin-point hæmorrhages or raised granular groups of lymphoid tissue may be regarded as highly suspicious. Normal saline may then be used to wash the mucous membrane, particularly at the involution of the preputial sheath. The washings may be examined by direct microscopic examination for viable trichomonads.

"Lazy Service"

The early symptoms of the acute, transient phase which may follow initial infection may not be noted by the stockowner and the first thing observed is a hesitancy in the bull's desire for coitus. This symptom, in association with the history of the number of cows returning to service, should always be regarded as suspicious of an early trichomonad infection. This hesitancy may develop still further into the recognised "lazy service." It is not uncommon to receive complaints from communal bull owners that their bull, despite his good physical condition, has become lazy or unwilling to mate. This symptom has not been fully recognised in dealing with cases of reputed impotency.

"Lazy service" may be due to other factors as well as to triochomonas infection, but its presence should always be regarded as suspicious of some form of infective sterility.

Reference may be made in this connection to some facts expressed by Lagerlöff (1936) in a paper given to the Veterinary Medical Congress in London, in which he discussed sterility in bulls in Sweden. He states that, of two thousand three hundred and thirteen bulls discarded in five years, 24 per cent. were discarded for sterility in one form or another. He records an interesting observation—"that the number of cases of incapacity to copulate surpasses the number of those with incapacity to fertilise." In his opinion the causes of incapacity to copulate are lack of exercise, too rich a diet, morbid changes in the skeleton and morbid changes in the penis and prepuce due to inflammatory changes. With regard to incapacity to fertilise he states the causes are an insufficient number of functional spermatozoa passing off with the ejaculate and that this, in turn, may be caused by morbid changes in the testes, epididymis, defferent ducts or in the accessory glands. Lagerlöff does not give his opinion as to the causal agencies of the morbid inflammatory changes in the penis and the prepuce leading to such a high percentage of bulls being cast as unfit for further breeding service. Nor does he mention *Trichomonas fœtus* as a cause of sterility, and apparently its presence is not recognised in Sweden. This is surprising, as it is much in evidence in Northern Germany.

It must be realised that the changes in the uterus produced by trichomonas is not the sole cause of sterility, even in trichomonas outbreaks. Disturbances to spermatogenesis in the bull as a sequel to morbid changes in the genitalia must not be overlooked. It is customary to accept the statement that a bull is normally fertile or altogether sterile without taking cognisance of any degrees of transi-

tion between these two. Trichomonad infection may lead to a mild form of sterility where a number of cows are in calf to first service, others require two or more services before conceiving and again others remain sterile. In such a case many months pass before a diagnosis can be established, and herein lies its difficulty, as the stockowner is inclined to assume that if there are calves as progeny to this bull, then that bull is free from blame. The experience in Northern Ireland is that such bulls become progressively worse and ultimately become sterile, but that this state is seldom reached before an exacerbation of symptoms appear amongst the cows.

An impression that is common knowledge amongst the Ulster farmer is that "the service feeds the disease." He knows if he stops breeding his cows and there are no sequelæ of pyometra, that after a period of six months the disease will have died down, indicating a limiting factor. On the other hand, if services are continued amongst these mildly affected cows the disease is maintained. There is much to be said for that point of view. A culture of *Trichomonas fœtus* injected into the vagina or uterus of an unmated cow will produce a definitely limited infection of short duration, but if the cow is served by the bull a strong possibility exists that the infection will persist. It is probable that the changes in the uterine mucosæ following œstrum, fertilisation of the ovum, and early development of the fœtus, creates a suitable medium for the development and maintenance of the trichomonad parasite. This would explain the importance of cessation of breeding as a control measure.

In view of his findings the author cannot agree with Abelein (1941), "that there is no evidence that trichomonads isolated from the urethra, the semen, and the blood stream are not *Trichomonas fœtus*." He confuses this issue at the outset by including the blood stream parasite described by Kust, Hees *et al.* with the normally associated trichomonad of the genital passage. In relation to this aspect of the problem the author has carried out cultural examination of 136 samples of blood taken from bulls, cows and heifers in natural outbreaks of trichomonas sterility and of samples of blood taken from cows, heifers and calves subjected to intravenous injection of a large number of live trichomonads with negative results. This aspect is dealt with in another paper. It is probable that the blood parasite described by Kust, Hees and others is a separate parasite (probably *Trypanosoma theileri*) and not in any way associated with the trichomonad infection of the genital tract found in Northern Ireland. It is interesting to note that we have found *Trypanosoma theileri* in blood cultures of bovines in Northern Ireland where blood was being examined for the presence of *Trichomonas fœtus*. As already stated, the author had found *Trichomonas fœtus* in the uro-genital tract of bulls. No satisfactory reason appears to exist why invasion from the preputial sheath to the uro-genital system should not take place, more particularly when we consider the negative geotropism and mobile characters of the trichomonad parasite. The finding of *Trichomonas fœtus* in the epididymis five months after the initial infection is noteworthy. The author agrees with Andrews and Miller (1938) that infection of the bull is chronic.

(*To be concluded*)

THE ACQUISITION OF MULES IN SOUTH AMERICA AND THEIR TRANSPORTATION TO INDIA—II

(*Concluded*)

By CAPT. T. L. WRIGHT, M.R.C.V.S.
Putney

Transport of Mules from Collecting Centre to Dock

EIGHT hundred and twenty-five mules had to be trooped about six miles to the station, thence about 350 miles by railway, after which they had to be watered and fed and rested for 24 hours before loading on board ship.

The railway cattle trucks each accommodate 33 small mules or 28 large. Twenty-six trucks had to be provided. Doors are at each end of each truck, not at the sides, and where the trucks meet each other, end to end, wooden platforms let down to bridge the couplings and buffers, thus, with the doors open, a series of trucks is just a long corridor which is shunted end on to the loading ramp up which the mules are driven and through the corridor of trucks until the farthermost has its allotted number, when the doors at the rear of the first truck and the front of the second truck are shut, and similarly until all are loaded. The 26 trucks were split up into two trains, sent on successive days.

While this was being done, forage was being inspected and loaded at the docks.

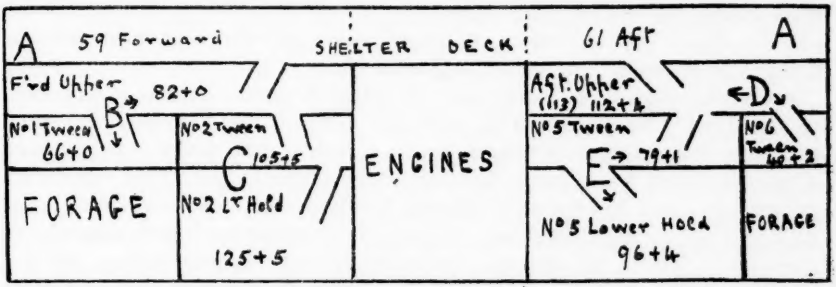
It had been decided to estimate for 43 days at sea and to carry a 50 per cent. reserve, with a daily ration of hay 8 kilos, oats ½-kilo, bran 1½ kilos.

The hay was in bales of an assortment of alfalfa, coarse mixture, and some soft meadow hay of an average weight of 30 kilos each, but varying considerably. The estimate required 11,350 bales, but actually 12,000 were loaded, as some of it had been stored a long time and had lost weight by evaporation. About 16 tons was rejected on inspection, as being unfit for food, and this was, of course, replaced. One thousand and sixty-four sacks of bran and 357 sacks of oats were loaded. More forage was loaded forward than aft, in proportion to the difference of mules to be loaded fore and aft. Provision had to be made for fresh water for drinking at the rate of 10 gallons per mule per day, for 20 days, as the ship would be putting into a port for water well within that period.

The ship was fitted with British standard horse fittings for 675 horses. It was desirable that it should take the largest possible number of mules. As fitted, there was a separate standing, or stall, for each horse, with the usual movable parting boards dropped into slots in the posts. By removing these boards from a number of divisions it is easy to make "pens" of varying size. The necessary alterations had to be carried out in accordance with the regulations and under the direction of the Animals' Sanitary Section of the Ministry of Agriculture of the Argentine Republic. This authority agreed that the ship could be fitted with accommodation for 870 mules. It was decided to embark 825 (120 large and 705 small) and reserve the remaining 45 (approximately 5 per cent.) for hospital accommodation. Actually, as the large mules required practically as much space as horses, the spares were only 3 per cent., but this proved ample. Checking up after loading it was found that 826 had been put on board.

When the necessary alterations to the standings had been completed, an inspection of the ship was carried out and a diagrammatic plan was sketched to

show the number of mules to be loaded in each section of each deck, and the number of spares to be left, thus—



Diagrammatic plan of the distribution of mules and their attendants on board ship. The numerals indicate the number of mules on each deck. + = spare stalls. Block letters (A, B, C, D, E) show sections for division of labour.

A—1	Deck Foreman	and	4	Argentine Men	(4	Cape Coloured	Corps)
B—1	ditto		4	ditto	(6	ditto	)
C—1	ditto		6	ditto	(8	ditto	)
D—1	ditto		5	ditto	(7	ditto	)
E—1	ditto		4	ditto	(6	ditto	)
COOK			1	ditto	(2	ditto	)
NIGHTWATCHMAN			1	ditto	(1	ditto	)

With this as a guide, and counting-in the mules, it avoided the risk of running too many mules on to a deck and having to send some back again (no easy task!).

Loading mules on to the ship was entirely in the hands of the Argentine Ministry of Agriculture in accordance with the Government regulations. These regulations require that mules are each fitted with a headstall and chain and are tied up in pens of five or seven, and until this stage was reached the mules were not under our control.

On arrival at the docks the mules were discharged from the trucks into a large corral, with water troughs and hay. After the stipulated rest they were driven, a few at a time, through a race in which each was fitted with a leather (raw hide) headstall and chain, and they passed on, in broken procession, like sheep or cattle, to the ramps, or gangways leading on to the ship. Those readers who are acquainted with the progress of untrained mules will readily understand that many of the breaks in the procession were of considerable duration. It took the official loaders two days and a half—23 working hours—to load 826 mules and tie them up.

At the end of the first day, only 230 mules had been loaded, and were all secured by head chains. During the night one jumped out of a pen and, being securely tied, broke its neck. Others broke headstalls or chains, and were left loose in the pens, as it was intended to let them all loose in pens as soon as we got out to sea, as experience in the last war had proved that they travel better loose—provided, of course, that they are unshod. In this way hay is fed to them on the deck instead of in nets—an economy in hay, as it all gets picked up and eaten; in nets, because mules soon begin to chew the rope nets even though tarred; and in time, because it takes considerable time for men to fill nets and take them round and tie to posts. In this respect one very remarkable thing was noticed. Whenever alfalfa hay was put down, the loose leaves were

never eaten. Every little piece of stem was consumed, but an irregular line of leaves, resembling the tidal marks of driftwood, corks, etc., on the shore of sea or tidal river, was always left. If one added a little fresh hay it would be eaten readily but still the leaves were left.

Personnel. A Britisher with many years' experience of estancias was engaged as foreman. He spoke Spanish fluently.

Circumstances made it necessary to engage Argentine citizens as muleteers to travel with the mules. This was done through the Embassy, and great assistance was rendered in this respect by a British mule dealer, who recruited a number of men from country areas where he did his buying. Thirty-four were engaged, but only 30 eventually reported for duty. Of these, one had to act as cook and one as night-watchman, leaving 28 for actual work with mules. For purposes of labour, the ship was nominally divided into five sections, and five men were selected, each to act as deck-foreman to a section, and men were allotted to each section in accordance with the number of mules combined with other circumstances affecting the facilities for work, so that the ratio varied from one man to 25 mules to one man to 35 mules. As water had to be carried in buckets from one or two centrally placed butts in each section to a galvanised iron trough-manger for each mule, and feed had to be similarly carried from mixing boxes, the work was strenuous, apart from the constant round of mucking out standings.

The Argentine Government would only permit their nationals to travel as far as South Africa, so arrangements had to be made through official channels for the disembarkation and repatriation of these men, and their replacement. The latter was effected by men of the Cape Coloured Corps, and will be dealt with later.

The voyage. As previously stated, the mules were all nominally tied up, in pens of five to nine per pen. On putting to sea, they were gradually set free and pens were enlarged by moving parting boards, so that greater freedom was given. By the end of the second day all were untied, and the two largest pens had 39 mules in each. The great majority had headstalls removed, but a few were left on.

With the long train journey to the docks, the rigours of loading and from one to two and a half days aboard a stationary ship, most of the mules did not get a very good start. Added to this, with few exceptions, they were untamed mules, and had never before been under cover or seen a manger or bucket, and were shy of feeding or drinking from these strange objects. They varied in their rate of adaptability to the new conditions. Three days after sailing about 10 per cent. were very thin. Some had come aboard thin because there had been almost a drought for three months in the region where they had been collected, and keep had been sparse. On the second day out, one colic case died of twisted small intestine. By the fourth day all were eating bran mash with a small addition of crushed oats. Water was left in all mangers at night. At 6 a.m. all mangers were removed and cleaned and bran mash was fed, and the men then had breakfast. After breakfast general routine cleansing of pens was carried out until noon, when bran and oats were given and the men then had dinner, and from 2 p.m. to 4 p.m., after which hay was put down and all mangers were filled with water. Between feeds, mangers were kept up, with water in, and it

was the night-watchman's duty to keep water supplied all night. The small staff did not permit cleansing of the whole ship every day. The best we could do was port side one day, amidships next day and starboard side the next, repeated, but we were several days out before this system was working properly. All the men were novices at this work. Periodically there was boat drill, and every man was instructed to carry his lifebelt with him everywhere. At 11.30 p.m. on the sixth night, the ship's siren sounded, resembling closely the call to "abandon ship." All the muleteers paraded at boat stations. It was very dark and raining hard. The men showed no sign of anxiety, and just "wondered what it was all about." It was soon ascertained that it was a false alarm and no danger existed, and all the men returned cheerfully to bed. It was found later that a rapidly rising wind had caused the crew to set-to to lower the canvas windshute ventilators, and while this was being done the wind carried one of them on to the wire-pull running from the bridge to the siren and set it in operation.

On the eighth and ninth days the ship was very unsteady and wind violent. Portholes and doors had to be kept closed all night, causing a stuffy atmosphere in decks below, and many mules were eating very much less than on the previous two or three days. Several of the men were seasick, and work slackened. Sea breaking into portholes in No. 1 'tween-decks necessitated much baling out, to prevent water (sea and urine) from getting into the forage in No. 1 hold. A few cases of pulmonary congestion resulted, but responded to hypodermic injections of spirits of camphor. One case of colic recovered after hypodermic injection of arecoline.

When the ship became steadier, many of the mules lay down to rest, and mucking out pens was resumed. To facilitate the latter, boards were removed and batches of mules—from 10 to 30—were ushered on to the deck in front of the pen, while the men worked unhampered in the pen and could lift the floor boards and clean underneath. When this was completed the batch of mules was put back in the pen, and another lot dealt with.

By the twelfth day there was improvement in the appetites of those mules which had been depressed, and some friction among the men over alleged unfairness of their cook in the distribution of food. The men, like the mules, were finding their appetites, but the trouble was soon settled by discussion.

Thirteenth day, only three mules were not feeding well. On the fourteenth day, violent wind and heavy swell developed and consumption of fodder greatly reduced. This was probably not due to lack of appetite, but to the animals' attention and efforts being almost entirely taken up with maintaining balance. In this respect it is noteworthy that mules and horses loose in pens on board a rolling ship do not stand with the long axis of the body at right angles to the side of the ship and sway to and fro with the roll of the ship (as they are compelled to do if tied in narrow stalls). They elect to stand diagonally and sway in such a way that the movement is from near hind to off fore, or conversely.

Fifteenth and sixteenth days, wind abated and deck cleaning was intensively carried out, so that we arrived at our first port of call reasonably clean on the sixteenth day.

The ship was anchored outside the docks, and water supply was replenished from tankers. Personnel had to be changed. The men of the Cape Coloured Corps came out on a tender, with kit and rations, etc., and the Argentinos went

ashore on the tender's return trip, to await repatriation. Our new staff consisted of four European staff sergeants and 34 coloured men (one had missed the train bringing them from camp to docks). Next day we resumed the voyage about 11.30 a.m. and went straight out into a heavy swell, and 75 per cent. of the new staff were seasick and unable to work. Mules were fed and watered with difficulty by the few men who were still able to get about, and the rolling of the ship seriously checked the mules feeding. A few instances occurred of portholes being opened for a little while and shipping seas, which had to be baled out owing to inefficiency of scuppers in some sections, and for three days (sixteenth, seventeenth and eighteenth of the voyage) no cleaning had been practicable.

On the nineteenth day the ship was steady, weather cool and all men back at work. Considerable progress was made with cleaning. Dung from the lower decks had to be put in baskets and hauled up by pulley to be thrown overboard. When the ship's steam winches could be used we used large baskets holding half a ton, but sometimes small baskets had to be used with manhandled pulley ropes. In this respect there was one amusing incident. A coloured boy was down in the lower hold hauling a rope to raise a basket about 40 feet and he was standing back under the hatchway and pulling in such a way that the rope was chafing on the iron girder. It was pointed out to him that he was making his labours unnecessarily hard, to which he replied: "That's all right, Sah! We're British soldiers, and have got to go through it!" However, for the sake of the rope, he was instructed to change his tactics.

By the twentieth day the standings had all been cleaned. On the twenty-first day we arrived at another port for fuel, and anchored outside. Later, berthed and took on more rations for Coloured Corps. The weather was very hot. We remained for four days. It was not permissible to dump anything overboard while in dock, so dung was accumulating all the time, as no lighters were available to remove it. The man who had missed our ship at our first port of call had made his way overland by train and joined us here. It was difficult to keep the men at work as their attention was constantly diverted to the multifarious happenings in the docks, which they had never seen before, and when unwatched they mostly had their heads out of portholes or doors. When we put to sea again dung was heaped in all available corners and passages, and this all had to be put overboard before the routine could be resumed, and that particular Sunday was a day of real hard work. With one exception the mules had all stood up to the heat and foul atmosphere, though appetites had diminished and the one exception had pneumonia very badly.

Weather now began to get very hot, but there was a strong breeze and with carefully adjusted wind-shute ventilators the atmosphere on the lower decks was kept tolerable. By Monday night (twenty-seventh day of voyage) all deck floors had been cleaned and next day men commenced lifting boards to clean underneath. From then until the thirty-third day, when we crossed the Equator, it became increasingly hot. One case of acute pulmonary congestion in a lower hold died in a few hours, and the long standing pneumonia case died. The men had to have longer periods of rest in the afternoons.

From the thirty-third to thirty-eighth day it was hot and calm.

Two unthrifty mules died, and post-mortem examination revealed severe strongylosis. One mule got out of a pen at night and slipped on an iron deck and broke its back and was shot. This brought the total losses to seven. Several of the unthrifty mules during this period had been turned loose to wander about the deck and feed at will and showed considerable improvement.

There were now no sick animals, and a few trivial injuries under treatment, and the rest of the voyage was uneventful until we arrived at our destination at dawn on the forty-first day, docked later and commenced disembarkation about 10.30 a.m. to 4.30 p.m., and completed by 2.30 p.m. next day, in a total working period of 11 hours. The surplus forage was then unloaded, taking till the early hours of the next morning.

Just before disembarkation of the mules a careful inspection showed that 45 per cent. were fat, 50 per cent. in good condition and 5 per cent. in poor condition. It was very probable that some of the latter were suffering from intestinal parasites.

Veterinary Stores and Equipment in Charge of the Veterinary Surgeon on Voyage from Buenos Aires to India, October 15 to November 29, 1941

Amount Received		*Surplus at End of Voyage*
2 drums	Disinfectant	Nil
2 litres	Spirits of camphor	1¾ litres
2 kilos	Acid boric	2 kilos
20 ampoules	Arecoline solution	13 ampoules
2 kilos	Chlorinated lime	2 kilos
2 tins	Tar	2 tins
10 kilos	Vaseline	10 kilos
500 tablets	Perchloride of mercury	440 tablets
20 litres	Linseed oil (raw)	20 litres
10 litres	Turpentine	10 litres
1 kilo	Sulphate of zinc	1 lb. 12 ozs.
1 kilo	Acetate of lead	1 lb. 12 ozs.
20 rolls (10 kilos)	Cotton wool	19 rolls
700 kilos	Mag. sulph. (Epsom salts)	700 kilos
70 kilos	Potass. nitras	70 kilos
2 10 c.c.	Hypodermic syringes	2
100	Hypodermic needles	100
6 tubes	Catgut suture	6 tubes
6 hanks	Silk suture	6 hanks
1 set	Steriliser and emergency instruments	1 set
1 each	Hoof knife and hoof rasp	1 each
6	Clinical thermometers	6
1	Emergency tracheotomy tube	1
5 vials	Local anæsthetic (sol. cocaine)	5 vials
1 pair	Long swabbing forceps	1 pair
50	Suture needles	50
10 tins	Tar for woodwork	Nil
30	Rakes	7
4	Sponges	2
2	Camp knives	2
4 tins	"Flit"	3 tins
2 large	Sprays	1
2 small	Sprays	2
2 pairs	Shears (wool or hair)	2 pairs

Above is a list of the veterinary stores and equipment showing the amount embarked and the surplus at the end of the voyage.

Method of handling. As the mules were all loose in pens and only very few had halters left on, it was necessary to catch any required animal for examination and treatment by slipping a rope noose over the head. It could hardly claim the dignified name of lassoing in most instances, for in some sections there was

little head room and the upright posts impeded the necessary swinging of a rope, but a very effective method was devised for the elusive animal. Fortunately, on this ship, the pens were constructed with a passage behind them as well as in front. A small batch of the mules, including the wanted animal, was ushered up to one end of the pen. Then the loop of the lasso was passed across the pen from front to back and was held in the form of two parallel lines a little above the head height of the mules. The separated batch was then ushered back towards the main body, preferably in single file or as nearly so as possible, and as the wanted animal was about to pass under the noose it was lowered and the man holding the distal end of the loop let go. Rather like a starting gate descending instead of ascending. The animal was then hauled up to a post and, if necessary, fitted with a headstall and chain. According to the treatment required, he was tied up or put in a small pen quickly made by replacing some of the parting boards in the slotted posts of the original horse stalls, the space allowed depending on the type of casualty and treatment required. A few vicious mules which threatened to injure or intimidate others in a pen were captured and put in separate stalls in solitary confinement. One, which had a slipped patella successfully reduced, was boxed in closely for several days and did well. All pulmonary cases were removed as quietly as possible to the best ventilated position available in the section and given a "separate room" of the area of two or three horse standings.

COMPARATIVE BLOOD PICTURE OF ARMY MULES AND HORSES

By P. G. D. MORRIS

Introduction

It was decided to examine the blood of horses and mules in order to ascertain whether there was any marked differences in the blood pictures.

Due to the kindness of Major Gillmor, R.A.V.C., an opportunity was given for taking blood samples from a group of twenty Army mules and a group of ten Army horses.

Technique

(1) The percentage hæmoglobin was estimated by means of the Dare hæmoglobinometer.

(2) Blood films were made and stained with Leishman's stain for differential counts.

(3) Red and white cell counts were made with the Metz hæmocytometer.

Differential Counts

In the case of each blood sample three hundred cells were counted, each count of one hundred cells being made on a separate film.

Results

Hæmoglobin. The percentage is 1.2 higher for the mules. (See Table IV.)

RBCs—Slightly higher count for the mules. (See Table IV.)

WBCs—Approximately the same for mules and horses. (See Table IV.)

Young Forms

The percentage in both mules and horses is small, but relatively four times as many were seen in the mules' blood.

Band Forms

0.232 higher percentage in mules' blood.

Polymorphonuclear Leucocytes (Class I)

12.17 higher percentage in horses. 33.86 per cent. in mules' blood and 46.03 per cent. in horses' blood.

Polymorphonuclear Leucocytes (Class II)

1.49 higher percentage of this class found in horses' blood.

Polymorphonuclear Leucocytes (Class III)

Very small percentage found in both bloods. 0.58 per cent. for mules and 0.232 per cent. for horses; thus indicating the number is almost 50 per cent. higher for mules.

Polymorphonuclear Leucocytes (Class IV)

None of this class noticed in horses' blood. 0.03 per cent in mules' blood.

Eosinophils

Percentage of this type of cell appears to be about the same. 5.02 per cent. for mules and 5.27 per cent. for horses.

Basophils

50 per cent. more in horses' blood. 0.43 per cent. in the mule and 0.827 per cent. in the horse.

Lymphocytes

There is a considerable difference between the percentage of these cells in the two bloods. 47.33 per cent. mule and 35.04 per cent. horse.

Monocytes

Percentage of these cells is approximately the same in both bloods.

Summary

From the above comparison of the blood pictures of Army mules and horses it will be seen that the main differences are:

(1) In the percentage of polymorphonuclear leucocytes (Class 1); 33.80 per cent. in the mule and 46.03 per cent. in the horse.

(2) The mules' blood contains a higher percentage of metamyelocytes. (Young and band leucocytes.)

(3) The percentage of lymphocytes higher in mules' blood; 47.33 per cent. in the mule and 35.04 per cent. in the horse.

Otherwise there is very little difference in the two blood pictures.

TABLE I

Blood Counts of each Individual Mule in the Group

Identification No. 427	Age 11 Count 1	RBCs 7,950,000 Count 2	WBCs 6,300 Count 3	Hb. 104% Av.
Y.	0.0	1.0	0.0	0.33
B.	0.0	0.0	1.0	0.33
Poly. I	38.0	39.0	49.0	41.855
Poly. II	20.0	19.0	8.0	15.66
Poly. III	4.0	0.0	1.0	1.66
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	1.5	2.0	2.0	1.83
Basophils	1.0	0.0	1.0	0.66
Lymphocytes	33.0	35.0	32.0	33.539
Monocytes	2.5	4.0	6.0	4.136

XUM

TABLE I—(*continued*)

	Age	RBCs	WBCs	Hb.
Identification No.	8	7,040,000	10,300	95%
401	Count 1	Count 2	Count 3	Av.
Y.	0.0	1.0	0.0	0.33
B.	0.0	1.0	0.0	0.33
Poly. I	31.0	30.0	32.0	31.03
Poly. II	2.0	0.0	0.0	0.66
Poly. III	1.0	0.0	0.0	0.33
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	12.0	7.0	14.0	11.00
Basophils	1.0	0.0	0.0	0.33
Lymphocytes	47.0	58.0	53.0	52.66
Monocytes	6.0	3.0	1.0	3.33

	Age	RBCs	WBCs	Hb.
Identification No.	8	7,870,000	6,400	110%
412	Count 1	Count 2	Count 3	Av.
Y.	0.0	0.0	0.0	0.00
B.	0.0	0.0	0.0	0.00
Poly. I	39.0	43.0	38.0	40.02
Poly. II	1.0	4.0	9.0	4.66
Poly. III	0.0	0.0	0.0	0.00
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	8.0	3.0	4.0	5.0
Basophils	0.0	2.0	0.0	0.66
Lymphocytes	47.0	42.0	42.0	43.66
Monocytes	5.0	6.0	7.0	6.00

	Age	RBCs	WBCs	Hb.
Identification No.	7	7,450,000	10,100	107%
414	Count 1	Count 2	Count 3	Av.
Y.	0.0	0.0	0.0	0.00
B.	0.0	0.0	0.0	0.00
Poly. I	49.0	43.0	38.0	43.33
Poly. II	1.0	1.0	0.0	0.66
Poly. III	0.0	0.0	0.0	0.00
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	3.0	3.0	1.0	2.33
Basophils	0.0	1.0	0.0	0.33
Lymphocytes	43.0	49.0	55.0	49.02
Monocytes	4.0	3.0	6.0	4.33

	Age	RBCs	WBCs	Hb.
Identification No.	6	7,270,000	7,700	112%
215	Count 1	Count 2	Count 3	Av.
Y.	0.0	0.0	0.0	0.00
B.	0.0	0.0	0.0	0.00
Poly. I	35.0	43.0	41.0	39.69
Poly. II	9.0	8.0	7.0	8.00
Poly. III	2.0	0.0	0.0	0.66
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	3.0	6.0	8.0	5.66
Basophils	0.0	1.0	1.0	0.66
Lymphocytes	48.0	37.0	41.0	42.00
Monocytes	3.0	5.0	2.0	3.33

	Age	RBCs	WBCs	Hb.
Identification No.	8	6,990,000	6,000	107%
221	Count 1	Count 2	Count 3	Av.
Y.	0.0	0.0	0.0	0.00
B.	1.0	1.0	0.0	0.66
Poly. I	42.0	39.0	42.0	41.02
Poly. II	6.0	9.0	7.0	7.33
Poly. III	0.0	0.0	0.0	0.00
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	6.0	8.0	3.0	5.66
Basophils	0.0	0.0	1.0	0.33
Lymphocytes	42.0	41.0	43.0	42.00
Monocytes	3.0	2.0	4.0	3.00

Identification No. 421	Age 9 Count 1	RBCs 7,410,000 Count 2	WBCs 7,800 Count 3	Hb. 80% Av.
Y.	0.0	0.0	0.0	0.00
B.	1.0	0.0	0.0	0.33
Poly. I	34.0	38.0	34.0	35.36
Poly. II	12.0	9.0	9.0	10.00
Poly. III	1.0	0.0	0.0	0.33
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	2.0	4.0	5.0	3.66
Basophils	1.0	0.0	0.0	0.33
Lymphocytes	45.0	47.0	47.0	46.33
Monocytes	4.0	2.0	5.0	3.66

Identification No. 472	Age 7 Count 1	RBCs 7,050,000 Count 2	WBCs 7,900 Count 3	Hb. 95% Av.
Y.	0.0	0.0	0.0	0.00
B.	0.0	0.0	0.0	0.00
Poly. I	22.0	28.0	29.0	26.34
Poly. II	12.0	10.0	9.0	10.33
Poly. III	0.0	0.0	1.0	0.33
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	1.0	2.0	3.0	2.00
Basophils	0.0	0.0	0.0	0.00
Lymphocytes	60.0	58.0	53.0	57.00
Monocytes	5.0	2.0	5.0	4.00

Identification No. 413	Age 8 Count 1	RBCs 6,910,000 Count 2	WBCs 7,600 Count 3	Hb. 87% Av.
Y.	0.0	0.0	0.0	0.00
B.	0.0	0.0	0.0	0.00
Poly. I	32.0	28.0	43.0	34.34
Poly. II	9.0	13.0	6.0	9.33
Poly. III	0.0	0.0	0.0	0.00
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	2.0	6.0	4.0	4.00
Basophils	2.0	0.0	1.0	1.00
Lymphocytes	51.0	50.0	40.0	47.00
Monocytes	4.0	3.0	6.0	4.33

Identification No. 218	Age 7 Count 1	RBCs 8,750,000 Count 2	WBCs 10,400 Count 3	Hb. 85% Av.
Y.	0.0	0.0	0.0	0.00
B.	0.0	0.0	0.0	0.00
Poly. I	35.0	43.0	46.0	39.84
Poly. II	15.0	5.0	8.0	9.33
Poly. III	0.0	0.0	0.0	0.00
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	5.0	9.0	8.0	7.33
Basophils	0.0	1.0	0.0	0.33
Lymphocytes	42.0	38.0	33.0	39.17
Monocytes	3.0	4.0	5.0	4.00

Identification No. 225	Age 7 Count 1	RBCs 4,640,000 Count 2	WBCs 9,625 Count 3	Hb. 105% Av.
Y.	0.0	0.0	0.0	0.00
B.	0.0	0.0	1.0	0.33
Poly. I	33.0	37.0	18.0	29.34
Poly. II	9.0	5.0	7.0	7.00
Poly. III	0.0	0.0	0.0	0.00
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	7.0	3.0	11.0	7.00
Basophils	0.0	0.0	0.0	0.00
Lymphocytes	45.0	53.0	58.0	52.00
Monocytes	6.0	2.0	5.0	4.33

XUM

TABLE I—(*continued*)

Identification No. 429	Age 8 Count 1	RBCs 7,900,000 Count 2	WBCs 10,300 Count 3	Hb. 95% Av.
Y.	0.0	0.0	0.0	0.00
B.	0.0	0.0	2.0	0.66
Poly. I	38.0	40.0	31.0	37.03
Poly. II	7.0	13.0	12.0	10.66
Poly. III	1.0	0.0	1.0	0.66
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	12.0	9.0	5.0	8.66
Basophils	0.0	1.0	2.0	1.00
Lymphocytes	41.0	33.0	42.0	38.00
Monocytes	1.0	4.0	5.0	3.33

Identification No. 471	Age 6 Count 1	RBCs 7,420,000 Count 2	WBCs 9,600 Count 3	Hb. 80% Av.
Y.	0.0	0.0	0.0	0.00
B.	0.0	0.0	2.0	0.66
Poly. I	27.0	20.0	25.0	24.00
Poly. II	16.0	21.0	18.0	18.03
Poly. III	2.0	4.0	2.0	2.66
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	4.0	4.0	0.0	2.66
Basophils	0.0	0.0	0.0	0.00
Lymphocytes	49.0	48.0	48.0	48.66
Monocytes	2.0	3.0	5.0	3.33

Identification No. 220	Age 8 Count 1	RBCs 7,890,000 Count 2	WBCs 9,400 Count 3	Hb. 95% Av.
Y.	0.0	0.0	0.0	0.00
B.	0.0	3.0	1.0	1.33
Poly. I	33.0	19.0	17.0	23.03
Poly. II	5.0	11.0	7.0	7.66
Poly. III	1.0	5.0	1.0	2.33
Poly. IV	0.0	2.0	0.0	0.66
Eosinophils	2.0	1.0	5.0	2.66
Basophils	0.0	0.0	0.0	0.00
Lymphocytes	56.0	59.0	65.0	60.00
Monocytes	3.0	0.0	4.0	2.33

Identification No. 212	Age 8 Count 1	RBCs 6,170,000 Count 2	WBCs 8,300 Count 3	Hb. 100% Av.
Y.	0.0	0.0	0.0	0.00
B.	2.0	3.0	2.0	2.33
Poly. I	28.0	24.0	20.0	24.03
Poly. II	7.0	4.0	6.0	5.66
Poly. III	1.0	0.0	4.0	1.66
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	5.0	9.0	5.0	6.33
Basophils	0.0	0.0	1.0	0.33
Lymphocytes	56.0	56.0	58.0	56.66
Monocytes	1.0	4.4	4.0	3.00

Identification No. 223	Age 8 Count 1	RBCs 7,360,000 Count 2	WBCs 9,900 Count 3	Hb. 89% Av.
Y.	0.0	0.0	1.0	0.33
B.	1.0	1.0	0.0	0.66
Poly. I	32.0	32.0	28.0	30.70
Poly. II	5.0	4.0	10.0	6.33
Poly. III	0.0	0.0	0.0	0.00
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	2.0	2.0	4.0	2.66
Basophils	1.0	0.0	0.0	0.33
Lymphocytes	56.0	60.0	54.0	56.66
Monocytes	3.0	1.0	3.0	2.33

Identification No. 428	Age 6 Count 1	RBCs 6,260,000 Count 2	WBCs 10,700 Count 3	Hb. 87% Av.
Y.	0.0	0.0	1.0	0.33
B.	3.0	2.0	1.0	2.00
Poly. I	30.0	24.0	30.0	28.03
Poly. II	4.0	4.0	5.0	4.33
Poly. III	0.0	1.0	0.0	0.33
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	6.0	13.0	7.0	8.66
Basophils	2.0	1.0	1.0	1.33
Lymphocytes	53.0	54.0	53.0	53.03
Monocytes	2.0	1.0	2.0	1.66

Identification No. 219	Age 8 Count 1	RBCs 7,060,000 Count 2	WBCs 10,750 Count 3	Hb. 105% Av.
Y.	0.0	0.0	1.0	0.33
B.	0.0	1.0	1.0	0.66
Poly. I	46.0	41.0	46.0	44.36
Poly. II	5.0	6.0	13.0	8.00
Poly. III	0.0	0.0	0.0	0.00
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	3.0	4.0	1.0	2.66
Basophils	0.0	1.0	0.0	0.33
Lymphocytes	44.0	47.0	35.0	42.00
Monocytes	2.0	0.0	3.0	1.66

Identification No. 217	Age 7 Count 1	RBCs 9,933,000 Count 2	WBCs 10,000 Count 3	Hb. 100% Av.
Y.	1.0	1.0	1.0	1.00
B.	2.0	1.0	7.0	3.33
Poly. I	35.0	26.0	28.0	29.67
Poly. II	10.0	8.0	6.0	8.00
Poly. III	0.0	1.0	2.0	1.00
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	6.0	3.0	6.0	5.00
Basophils	0.0	0.0	0.0	0.00
Lymphocytes	44.0	56.0	44.0	48.00
Monocytes	2.0	4.0	6.0	4.00

Identification No. 423	Age 5 Count 1	RBCs 8,150,000 Count 2	WBCs 9,900 Count 3	Hb. 96% Av.
Y.	0.0	0.0	0.0	0.00
B.	1.0	0.0	0.0	0.33
Poly. I	34.0	38.0	30.0	34.02
Poly. II	11.0	8.0	17.0	12.00
Poly. III	0.0	0.0	0.0	0.00
Poly. IV	0.0	0.0	0.0	0.00
Eosinophils	6.0	6.0	7.0	6.33
Basophils	1.0	1.0	0.0	0.66
Lymphocytes	40.0	40.0	38.0	39.33
Monocytes	7.0	7.0	8.0	7.33

B. = Band Form metamyelocytes—the nucleus indented but showing no lobulation.

Y. = Metamyelocytes.

TABLE II

Average Blood Count for each Individual Mule

No.	Age	RBCs	WBCs	Hb. %	Y. %	B. %	Poly. I %	Poly. II %	Poly. III %	Poly. IV %	Eosino-phils %	Baso-phils %	Lympho-cytes %	Mono-cytes %
427	11	7,950,000	6,300	104	.33	.33	42.185	15.66	1.33	—	1.83	0.66	33.539	4.36
401	8	7,040,000	10,300	95	.33	.33	31.03	.66	.33	—	11.00	0.33	52.66	3.33
412	8	7,870,000	6,400	110	—	—	40.02	4.66	—	—	5.00	0.66	43.66	6.00
414	7	7,450,000	10.100	107	—	—	43.33	0.66	—	—	2.33	0.33	49.02	4.33
215	6	7,270,000	7,700	112	—	—	39.69	8.00	0.66	—	5.66	0.66	42.00	3.33
221	8	6,990,000	6,000	107	—	.66	41.02	7.33	—	—	5.66	0.33	42.00	3.00
421	9	7,410,000	7,800	80	—	.33	35.36	10.00	0.33	—	3.66	0.33	46.33	3.66
472	7	7,050,000	7,900	95	—	—	26.34	10.33	0.33	—	2.00	—	57.00	4.00
413	8	6,910,000	7,600	87	—	—	34.34	9.33	—	—	4.00	1.00	47.00	4.33
218	7	8,750,000	10,400	85	—	—	39.84	9.33	—	—	7.33	0.33	39.17	4.00
225	7	4,640,000	9,625	105	—	.33	29.34	7.00	—	—	7.00	—	52.00	4.33
429	8	7,900,000	10,300	95	—	.66	37.03	10.66	0.66	—	8.66	1.00	38.00	3.33
471	6	7,420,000	9,600	80	—	.66	24.00	18.03	2.66	—	2.66	—	48.66	3.33
220	8	7,890,000	9,400	95	—	1.33	23.03	7.66	2.33	.66	2.66	—	60.00	2.33
212	8	6,170,000	8,300	100	—	2.33	24.03	5.66	1.66	—	6.33	0.33	56.66	3.00
223	8	7,360,000	9,900	89	.33	0.66	30.70	6.33	—	—	2.66	0.33	56.66	2.33
428	6	6,260,000	10,700	87	.33	2.00	28.03	4.33	0.33	—	8.66	1.33	53.03	1.66
219	8	7,060,000	10,750	105	.33	0.66	44.36	8.00	—	—	2.66	0.33	42.00	1.66
217	7	9,933,000	10,000	100	1.00	3.33	29.67	8.00	1.00	—	5.00	—	48.00	4.00
423	5	8,150,000	9,900	96	—	0.33	34.02	12.00	—	—	6.33	0.66	39.33	7.33

TABLE III

Blood Counts of Ten Army Horses

Horse No.	Age	Hb. %	RBCs	WBCs	Y. %	B. %	Poly. I %	Poly. II %	Poly. III %	Poly. IV %	Eosino-phils %	Baso-phils %	Lympho-cytes %	Mono-cytes %
594 M	10	105	7,000,000	8,900	0.33	0.33	47.66	10.35	—	—	5.00	3.33	30.00	3.00
501 G	7	95	7,000,500	9,300	—	0.33	42.67	8.00	—	—	7.00	1.00	38.00	3.00
582 G	9	90	7,150,000	9,600	—	0.70	53.30	11.30	1.00	—	0.70	0.30	31.00	1.70
853 M	9	98	7,650,000	10,100	—	—	47.00	8.00	—	—	2.00	—	38.00	5.00
541 M	11	99	7,000,000	9,300	—	1.33	31.33	5.66	0.33	—	4.66	0.33	51.76	4.60
526 M	8	98	7,650,000	9,600	—	1.00	41.00	11.00	0.33	—	4.00	0.66	37.64	4.37
400 M	14	87	8,460,000	10,800	—	—	61.00	9.66	—	—	2.33	0.33	24.68	2.00
110 G	8	95	3,960,000	9,200	—	0.66	45.33	14.36	0.65	—	5.00	0.33	30.00	3.66
548 G	9	100	8,130,000	5,700	—	—	47.33	8.00	—	—	7.33	0.66	32.68	4.00
201 G	10	87	9,490,000	6,600	—	0.33	43.66	10.36	—	—	4.66	1.33	36.66	3.00

M = Mare. G = Gelding.

TABLE IV

Comparative Blood Picture of Army Mules and Horses

	Mule	Horse
Age (years)	7.5	9.5
% Hæmoglobin	96.7	95.4
RBCs	7,373,650	7,349,000
WBCs	8,949	8,910
Young Forms	.13%	.033%
Band Forms	.70%	.468%
Poly. I	33.86%	46.03%
Poly. II	8.18%	9.67%
Poly. III	.58%	.232%
Poly. IV	.03%	Nil %
Eosinophils	5.05%	4.278%
Basophils	.43%	.827%
Lymphocytes	47.33%	35.04%
Monocytes	3.67%	3.43%

FOOD AND POISON GAS—II

PART III

By DR. JOSEPH DOWGIALLO

Decontamination

Quite often food contaminated by poison gas can be decontaminated. The methods of decontamination are: (1) mechanical; (2) physical; (3) chemical.

1. *Mechanical* method of decontamination consist of: (a) cleaning the poisonous residue from the exterior surface (dust, spots, etc.); (b) cutting off the exterior layer (e.g., from meat); and (c) shovelling up of outer layers (e.g., grain, potatoes, etc.). The layers which are removed must be destroyed, otherwise they may become the source of further contamination and poisoning. Their removal must be carried out with a certain amount of caution (wearing of special gloves and sometimes anti-gas clothing), and must be done where there is a free passage of air and the wind is blowing away from the food, or where the fumes can escape up a chimney or ventilator shaft. (d) With water, even the most primitive methods of filtration will give quite satisfactory results if the water is afterwards boiled.

2. *Physical* methods of decontamination are based on: (a) airing or ventilation; (b) washing; and (c) cooking of the contaminated foodstuffs. (a) Vigorous airing is a very efficacious means of decontamination and will often suffice for the total removal of poison from grass, grain and feeding-stuffs which have been contaminated by volatile non-persistent gases. The best way for rapid decontamination is to spread the affected product in the open air and turn it over frequently until all smell and irritation have disappeared.

Wind, warm weather and especially sunshine have a large influence, because they accelerate the evaporation of the poison. Wet weather also aids decontamination by washing away the poison or destroying it. With a small quantity of food the best and quickest way is to heat, boil or wash with hot water. Poison does not always evaporate in the open air. More persistent gas, e.g., mustard gas, does not evaporate in a temperature below 10 deg. Cent. to 14 deg. Cent. It is not always possible to expose food to the air for a long time (i.e., fresh meat).

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In this case the best method of decontamination is by cooking. Cooking acts in two ways: it causes hydrolisation and at the same time removes the poison by evaporation. The part which is not hydrolised is still dangerous and cooking must continue for at least two hours (sometimes three hours) in a constant passage of fresh air or where the dangerous vapour can escape by way of the chimney.

After boiling contaminated meat the first water must be thrown out immediately because the unhydrolised poisonous sediment can remain in it. When arsenical gases are introduced into water, they are broken up into their separate components, some of which hydrolise and some of which are stabilised and are very dangerous. Therefore, when the presence of arsenic or other poisonous elements have been established by chemical examination, the food must be destroyed or used as a fertiliser.

If the contamination is only on the surface, as from fumes of smoke gas, decontamination can be effected by the removal of the superficial layers and afterwards boiling.

As already described, food contaminated by gases in Group IV cannot be decontaminated by boiling alone. This must be preceded by mechanical action.

3. *Chemical* methods of decontamination are based on rendering the poison harmless by oxidising, chlorinating or hydrolising them. The methods are efficacious but not always practical with food, because after such decontamination it sometimes becomes unpalatable. Among the well-known choking gases which do not hydrolise is chloropicrin; it is therefore impossible to decontaminate exposed foodstuffs by washing only. Sodium thiosulphate (Na_2 SO_3) reacts very quickly, removing the poison from the surface of the meat, etc., which can afterwards be washed, and so completing the evaporation of the remainder of the free poison. Sometimes, however, particles of poison can become fixed in the food and consequently there will still be great danger. After decontamination by sodium sulphate (Na_2 S_2O_3) the food will taste salty and it must again be washed in clean water. Decontamination of meat can also be accomplished by washing with soap and water and afterwards washing again very carefully in clean water.

Oxydisation can be accomplished by using potassium permanganate ($KMNO_4$), which renders the poison harmless (i.e., mustard gas), but afterwards water will have a metallic taste and the colour is sometimes altered. Food treated in this way may not be palatable for the above reasons, though it is not dangerous to eat.

Chlorination* is used to destroy blister gas (mustard gas) but the residue of the chlorine has a repulsive smell or taste which renders treated foodstuffs unpleasant to eat, although they are not dangerous.

*This is the same as oxydisation.

PART IV

Valuation and Procedure for Dealing with Food Contaminated by Poison Gas

General Remarks on Initial Inspection

To estimate the value of contaminated food it must be ascertained how, where and when it was contaminated. This is important in order to establish the *degree of contamination.* It is also important to know whether the food was protected

or not, the method of protection, distance from place of explosion, direction and strength of wind, cold, warm, wet, etc.

In the case of very strong contamination the food must be destroyed immediately by burying or burning or covered with bleaching powder (lime bleach). It is sometimes possible to send this food to the public incinerator.

One should ascertain the degree of contamination and whether the food is in a car, shop, store, factory, field, or if live animals are affected. The different degrees of contamination as classified are: very strong, strong, and light.

How long contamination has been present? Heavy contamination usually lasts for 48 hours and longer. *Very strong* and *strong* contamination causes changes in the colour of the food and a strong peculiar odour. *Lesser* degrees of contamination cause strong smell and eventually change of colour. With low degrees usually only the strange odour is present. Distinguishing by *smell* is the first factor in establishing not only the type of gas used but sometimes also the degree of contamination. It is important to note that when local or technical difficulties occur a sample of the food should be taken to a laboratory. It should also be noted that very volatile gases, such as hydrocyanide (HCN) or carbon monoxide (CO), cannot be used in the open air and are only effective in confined spaces.

General Procedure

If the food was protected, remove the contaminated outer covering, which must either be destroyed or decontaminated. Any efforts to decontaminate food in large quantities should be carried out in the open air if at all possible. Smaller quantities can be dealt with in a room which is adequately ventilated. Protective clothing should be worn in most cases, especially with blister gas, and the clothes afterwards decontaminated.

A change in the taste of foodstuffs which have been decontaminated does not necessarily indicate that the food is dangerous to eat, as this can sometimes be the result of the action of the product used to destroy the poison. The taste may be salty or acid from gases in Group I.

Detailed Procedure

1. *Slaughter of animals.* All animals contaminated by poison gas, without regard to the type of gas used or degree of contamination, can be used for food provided that their skin is first decontaminated and that there is at this time no sign of contagious disease or sepsis. Heavily contaminated animals must be immediately slaughtered, after the skin has been decontaminated, and care must be taken that neither the workers nor the flesh become contaminated. If contamination is only slight, it is not necessary to slaughter the animal immediately. After treatment it can be allowed to return to pasture. Where there is a medium degree of contamination and the animal is likely to be ill for any length of time, it is advisable to slaughter immediately to prevent deterioration of the meat.

Decontamination after blister gas is best carried out before slaughter. When removing the skin from the animal, it should be borne in mind that the hair may still retain a certain amount of poison and the skin should be stripped and rolled inside out. For non-blister gases it will be sufficient to wash the hair and skin with water. Decontamination of the skin after blister gas is carried out by washing several times with warm, soapy water or a solution of chloride of

lime (bleach). Gas clothing and mask should be worn. Washing is most advantageously carried out with a hose. Hair retains blister gas from seven to ten days. After the skin has been removed all affected parts must immediately be cut away. These parts appear as reddish-grey or brownish spots.

2. *Small edible animals.* Small animals, such as the rabbit and hare, are easily contaminated, because their fur can retain blister gas from seven to ten days and is therefore a source of contamination to the animals themselves and their surroundings. All marked places should be cut away and destroyed, also the head and intestines. It is not worth while decontaminating very small animals from blister gas.

3. *Fowls.* The feathers on fowls do not permit of easy penetration of the poison to the skin, although a certain amount of liquid blister gas may reach the skin by absorption into the grease in the feathers, where it may be retained for about a week. After several hours it may penetrate to the sebaceous glands of the skin and it is then impossible to remove the poison by washing alone.

The fowl should be washed in hot water, plucked and any marked places on the skin removed. Head and intestines should be destroyed. In the case of heavy contamination by blister gas it is better to destroy the whole fowl.

4. *Fish.* The parts of the fish not covered by scales are easily penetrated by poison gas. Several hours after contamination by liquid blister gas blisters are visible on the skin. Scaly parts will resist all gases quite well. As a rule, fish in heavily contaminated water will die within three hours. Poisoned fish will be found among weeds and water plants, where they usually go to die. It is fairly difficult to remove the contaminated scales. It is always advisable to wash fish in hot water and boil before using for food (frying, etc.).

5. *Meat.* Cut meat absorbs poison easily because of the outer layer of fat and a certain quantity of water. Beef, veal and mutton contain on an average about 75 per cent. water, 20 per cent. protein combination, 1 per cent. mineral and a variable degree of fat—from 4 to 10 per cent., and in very fat meat as much as 25 per cent. Pork contains more fat and less water and protein combination.

Contamination of a quarter of meat even by blister gas is not generally deep (3-10 mm.). Fresh warm meat absorbs most poison; cold absorbs less, and frozen meat only becomes superficially affected. When frozen meat is thawed out the poison penetrates very quickly into the tissues. Smoke gases also contaminate only superficially.

In the case of strong contamination or contamination of a medium degree, by blister gas, the top layer must be removed to a depth of .5-1 cm. With a low degree of contamination as well as by non-persistent gas (volatile), washing the meat will suffice, but if there are suspicious-looking marks on the surface, cutting up is indicated. The layer of fat absorbs the poison more deeply than the other tissues and must be removed in cases of heavy or lesser contamination. In heavy or medium contamination by blister gas the preparation of meat for consumption should be carried out by boiling. Boiling the meat causes destruction of the poison of mustard gas partly by hydrolising and partly by evaporation.

If it is not necessary to prepare the meat immediately, it can be put after washing into the refrigerator or preserved in salt, etc.

It is possible to decontaminate meat tainted by chloropicrin by washing with soap and water or by sodium thiosulphate ($Na_2 S_2O_3$) or even with sodium bicarbonate. After these operations it is necessary to wash the meat again in clean water, otherwise there will remain a soapy or chemical taste. Meat in small pieces or finely chopped is contaminated with greater ease.

6. *Fat, bacon and other greases* readily absorb the most poison gases and their decontamination presents many difficulties. For example, mustard gas may be given off from fat even after boiling. Lewisite can be destroyed by water but will leave its poisonous arsenical residue. This is usual with gases having arsenical compounds and it is also true of gases which contain compounds of heavy metal and phosphorus.

The skin of bacon is no protection against penetration by blister gas. If at all in doubt, this type of food is better destroyed. For large supplies, expert analysis is necessary.

In all cases of low contamination it is better either to cut away the fat and boil it or melt it, and use a little at a time, or mix it with uncontaminated fat. After boiling, the water should be thrown away.

7. *Ham, preserved meats, etc.* These meats contain a much smaller quantity of water and are more compact than fresh meat; but contamination is easy. The greater the quantity of fat in the product the greater will be the danger of contamination. The skins which cover sausages, etc., may stop a certain amount of gas penetration from smoke gases but are no safeguard against other gases, more especially blister gas, which will penetrate in a very short time. Ham can be rendered safe by cutting off the skin, chopping it into small pieces, washing, and then boiling.

8. *Soups, spirits, fluids, etc.* Any fluids, and more especially if they contain particles of fat or alcohol, which absorb and dissolve poison gas but do not destroy it, are very dangerous, even if contamination is only slight. They are best destroyed, as their value is practically negligible. It is usually noticed that the taste of most fluids is changed after contamination, becoming either salty, acid or bitter, and for this reason alone they are unfit for use. The same remarks apply to jam and other liquid preserves.

9. *Eggs.* The eggshell is not sufficient protection against contamination, especially by blister gas, because the shell is porous. Careful examination of each particular egg will show the degree of contamination by its peculiar smell or change of colour. After removing the shell the contents must be also examined for smell and colour change. The white of the egg will curdle after strong contamination. After decontamination the eggs can be used for cooking but it is never advisable to use them raw.

Eggs contaminated by blister gas can be used after the shells have been treated by immersion for about 15-30 minutes in a solution of lime bleach.

10. *Butter, margarine and cooking fats* are easily contaminated and very difficult to decontaminate. Only 10-15 per cent. of mustard gas can be removed

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by evaporation. Most of these products are therefore unfit for use and can only be used industrially, e.g., for manufacturing soap, etc. Great care must be taken when working with them.

Decontamination of these products is carried out by melting and boiling, and it is advisable to mix the decontaminated fat with other substances. Boiling will not destroy the poisons of Group IV gases and the product should be analysed if there is any doubt of residual contamination.

11. *Cheese.* This product contains a high percentage of protein and a certain amount of fat, which easily absorbs the poison gas. It is usually very difficult to decontaminate. Decontamination is carried out by removing the rind and washing the cheese in hot water. Airing is generally insufficient. It can then be grated and used for seasoning, etc. It is always better to use decontaminated cheese sparingly and for cooking purposes, especially when it has been contaminated heavily or with gases from Group IV.

12. *Milk* curdles very easily after contamination. Curdling may follow immediately after contamination or during boiling, but more rarely after boiling. If in doubt, always boil the milk. A peculiar smell or taste is also a good guide. In all doubtful cases, expert advice must be sought to detect possible presence of arsenic. Cream cheese, curds and other milk products absorb poison gas very easily; decontamination is very difficult and often impossible.

13. *Bread.* The crust of bread has a smooth, even surface, which arrests a small quantity of the poison, and should therefore be removed. If bread is moistened and rebaked the gas will evaporate, provided it is non-arsenical. For quick evaporation the bread should be cut into thin slices and baked dry in the oven, which should, of course, be well ventilated. For drying ship's biscuit, the same procedure can be adopted. To determine the degree of contamination or of decontamination during baking or drying, smelling and tasting are quite effectual. If there is contamination by blister or arsenical gas (Group IV) chemical analysis is necessary.

14. *Grain, corn and growing crops.* Stored grain, even in large quantities, will not be contaminated below the surface. Usually liquid poison gas will not penetrate deeper than 5 cm. and in the case of strong contamination very seldom deeper than 10 cm. As a rule, by careful removal of the superficial layer and afterwards spreading out and airing, decontamination is possible. The greatest danger is with arsenical and phosphorus gases, but if there is only surface contamination the outer layer can be removed carefully.

If *growing crops* are left standing in the field for some time the poison will evaporate. It is necessary to destroy all obvious places of contamination, such as shell-holes and craters, otherwise they will only be a source of further danger. The holes should be filled in and covered with sand and bleach.

15. *Flour* has a large surface and small bulk and retains poison in the superficial layer, especially the blister gases. Detection is easy, because small lumps appear on the surface owing to the adhesion of the particles of the flour. These lumps are separated easily from the rest of the flour by passing it through a sieve. Liquid gas poison does not penetrate deeper than 3-5 cm. After separa-

tion of the contaminated lumps, the flour should be spread out and aired for some time, and it can then be used for cooking. The contaminated lumps must be destroyed.

Flour in bags can be decontaminated by removing the obviously affected parts and in the case of a low degree of contamination spreading out and airing will suffice.

16. *Groats, meal, rice, etc.* Because of their smooth and shiny surface the degree of contamination will be low, except with liquid gases, where penetration will be deeper. They are, however, easily decontaminated.

17. *Oats and barley* decontamination is simple because these cereals can be left for a longer time in the fresh air. They should be used sparingly and mixed with uncontaminated grain. If scalded with hot water, there will be more rapid decontamination.

18. *Peas, beans and other green vegetables.* Fresh green vegetables are more easily contaminated than dried vegetables because of their greater water content and their soft, moist skin, which can absorb the poison more quickly than dry forms. When dried vegetables are exposed in bulk to liquid poison gas the liquid will run off the shiny surface to the under layers. However, if they are washed and thoroughly aired they are fit for use.

19. *Potatoes and other root vegetables.* A small quantity of poison may remain on the skins of potatoes and penetration through the "eyes" is possible, especially with liquid blister gas. Potatoes stored in mounds in the open will not be badly contaminated, because the gas will only penetrate the top layer to a depth of 10 cm. (one potato). If stored in mounds covered with earth, 10 cm. deep will be sufficient protection. Thick sacks also afford a certain amount of protection.

20. *Fruit.* The skins of apples, pears, etc., resist poison quite well because of their smooth, shiny surface. Soft fruits are more liable to heavier contamination because of their non-resisting skins and are difficult to decontaminate. It is advisable to remove the skin and boil the fruit. Dried fruits can be decontaminated by further drying in a hot oven until all smell and irritation have disappeared.

21. *Sugar.* As sugar is a carbohydrate and very porous, it can adsorb poison easily. It can give off the poison quickly. It can be decontaminated by vigorous airing or by boiling, during which the poison will evaporate or be destroyed. The sugar should afterwards be used as syrup.

21a. *Chocolate and sweets.* Because of the fatty content of chocolate it will absorb poison with ease. Other sweets have a sugar content which is fairly indifferent to the poison. Products packed in tins, boxes, tinfoil, etc., are fit for use when unpacked. If, however, the packing is bad, the same procedure as for fat and sugar must be followed. Decontamination is very difficult with a heavy degree of contamination, and with gases in Group IV it is almost impossible and the taste is likely to be changed. Decontamination of low degree is best carried out by airing until all smell and irritation have disappeared. It is best to use the chocolate for cooking. If doubtful, it should be destroyed.

XUM

22. *Salt* (*coarse, table and mineral*). Salt of all descriptions adsorbs poison and gives it off easily. Decontaminate by airing after removal of superficial layer, but this is not absolutely foolproof. The better method is to boil in a saturated solution and the residue will be safe to use. Stir when boiling. Decontamination with gases from Group IV is very difficult and is limited to the low degrees of contamination.

23. *Tea, herbs, etc.* These substances are like hay; they have a large and very porous surface and the superficial layer is easily contaminated. Contaminated tea, etc., has a salty, acid or bitter taste. Poison can be removed by airing or exposing to hot air for from one to three hours until all smell and irritation have disappeared. There must be an adequate outlet for the poisonous vapour. The above process will remove some of the flavour and it is therefore advisable to mix the decontaminated products with uncontaminated samples. The tins and lead foil in which tea, etc., is usually packed, afford quite good protection provided they are absolutely intact.

24. *Coffee and cocoa.* Coffee beans should be treated as any other beans, although, after roasting, they become more porous. They are usually contaminated on the top layer only. The taste of contaminated coffee will usually change and become salt or bitter. Decontamination is carried out by airing, but the best method is to roast again for from one to three hours until all smell and irritation have disappeared, taking care that the ventilation is adequate.

Ground coffee and cocoa must be treated in the same manner as flour.

Coffee and cocoa packed in tins are quite safe, but if in paper without tinfoil, protection is only partial and poor.

25. *Growing grass, pasture, etc.* (Growing crops—No. 14.). Self-decontamination can be effected by airing, which is the only practical method of removing the poison. The time taken will depend on the time of year, atmosphere, type of gas used and degree of contamination. It is important to remember to fill in all shell-holes and bomb-craters, as they will remain a source of further contamination. Decontamination of a limited area can be done by painting with lime-bleach. The public must be protected by erecting notice boards, e.g., "Danger—Gas Contamination. No admittance or grazing until ———."

26. *Hay and straw.* These feeding-stuffs have a large surface and are of loose bulk. The looseness in packing leads to deeper penetration, which depends on the type of gas used. Bales of hay and straw will not be contaminated in such deep layers as hay which is loose or in trusses. A strong smell of the poison gas after removing the top layer to a depth of 5-15 cm. is usually the best guide in determining the degree of contamination. Airing is the best method of decontamination. In winter this will take longer (blister gas, one to three months) than in summer (one to three weeks).

27. *Tobacco, cigars and cigarettes.* The leaves of tobacco are porous and highly absorbent. The packing of these products is usually sufficient protection, especially when covered with tinfoil or packed in tins. Tobacco contaminated by blister gas can be decontaminated by washing and drying—if by non-persistent gases, airing will suffice. With gases from Group IV decontamination is more

difficult and analysis is advised. Moreover, the change of aroma and taste will render detection easy.

28. *Water* contaminated by poison gas is recognised easily. Many different methods are available to decontaminate water, but often it cannot be used for drinking, etc., even though it is not dangerous, because of its changed taste and smell.

(*To be continued*)

Abstract of Current Literature

Heredity in Periodic Ophthalmia. By T. C. JONES and FRED. D. MAURER. *J.A.V.M.A.* CI, *787*, 248-249.

INVESTIGATIONS took place at U.S. Army Remount Depot, Front Royal, Virginia, in order to ascertain if heredity was of significance in periodic ophthalmia. The authors had access to family histories and veterinary records. Horse families for which there were adequate records total: 20 sires, 56 dams, with 368 offspring.

Of 368 foals 46 had periodic ophthalmia. Of these 34 were the progeny of negative sires and dams, 12 were the progency of sire or dam which had periodic ophthalmia.

Of these 12, five were by a sire and seven from a dam with periodic ophthalmia.

Of the 56 mares 10 had periodic ophthalmia.

Of the 46 with no occular disease 23 had offspring with periodic ophthalmia.

Of the 10 mares with periodic ophthalmia six had offspring with the disease.

The authors conclude that from the limited data presented, heredity does not appear to play an important role in the etiology of the disease.

In support of this contention they state:

(1) As a rule, inflammatory diseases are not hereditary.
(2) Literature presents little statistical data.
(3) The regional occurrence of the disease is difficult to explain on a purely hereditary basis.
(4) The prevalence of the disease in certain regions has remained relatively constant in spite of considerable inter-regional movement of horses.
(5) If heredity was a prime etiological factor the incidence in all regions should be now at an approximal natural average.
(6) There is little reason to suspect heredity for the high incidence among American raised army horses in the Philippines.

Summary of Statistics:

26.0 per cent. which developed P.O. were from affected sire or dam.
6.8 per cent. of offspring from two sires with P.O. developed the disease.
15.5 per cent. of offspring of 18 normal sires developed the disease.
18.4 per cent. of offspring from 10 mares with periodic ophthalmia developed the disease.
15.6 per cent. of offspring from 46 normal mares developed the disease.

Review

A Handbook of First Aid and Bandaging. By ARTHUR D. BELILIOS, M.B., B.S., and others. Reprint May, 1942. Baillière, Tindall & Cox. Price 4s. 6d.

VETERINARY surgeons in training pass through a course which is basically similar to that of the human doctor. Whereas the human doctor confines his activities to the care of one species the veterinary surgeon has to turn his attention to a great variety of patients. It is reasonable to suppose that, with no great effort, he could render valuable aid to humans should the necessity arise. That emergency may occur at any moment in a total war and the medical services may need all the skilled help that can be recruited. For this reason, in particular, and also on account of the emergencies of normal life, it would be a good plan if veterinary surgeons were to familiarise themselves with all aspects of first aid work. They are in a position to profit from more advanced instruction than that which it is customary to give to the lay first aid worker.

"First Aid and Bandaging," by Arthur D. Belilios, M.B., B.S., should go far to fulfil this requirement. It is a book of 610 pages, incorporting XLV chapters and an excellent index. There are 259 excellent illustrations. The book is a considerable advance on the usual first aid books, but its title is somewhat misleading, for a title such as "Minor Emergency Medicine and Surgery" would have been more appropriate. The reader to whom the basic sciences of anatomy, physiology, etc., are familiar will find much interesting matter within its pages and should experience no great difficulty in applying its teaching to the emergencies of daily life. We doubt if it will be of much use to the average layman, for most of the material will be beyond the appreciation of one not acquainted with the principles of the basic sciences.

It is well worth a place on the veterinary surgeon's shelf.

NOTE.—The 1942 Index will be published as a loose leaf with the January issue.

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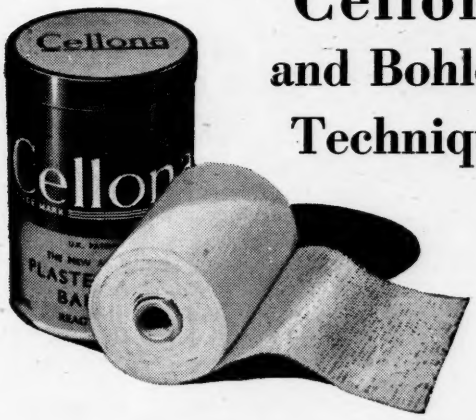

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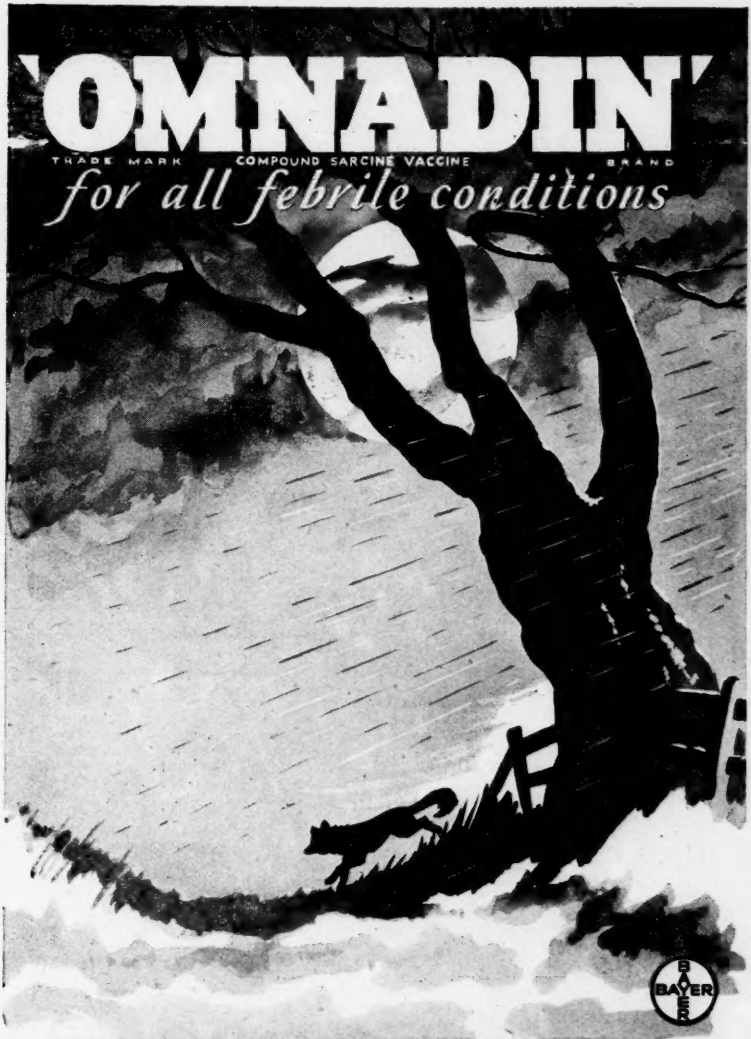

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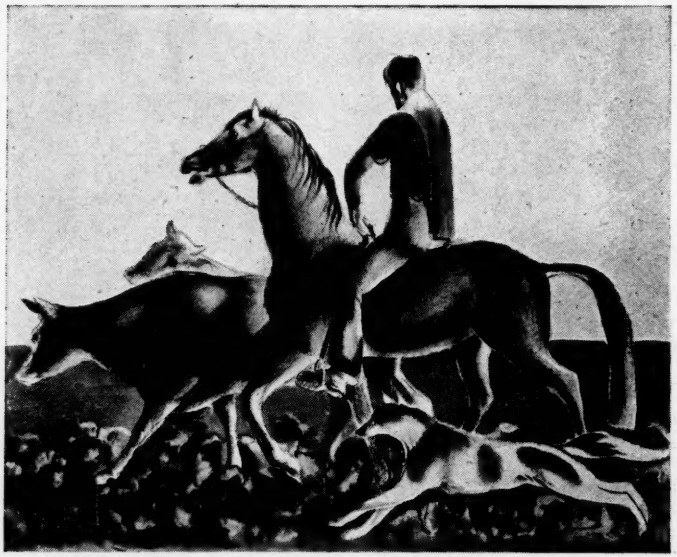

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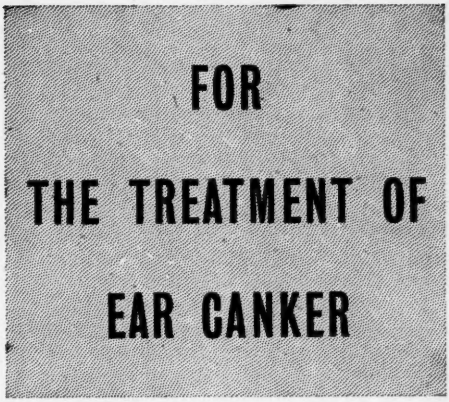

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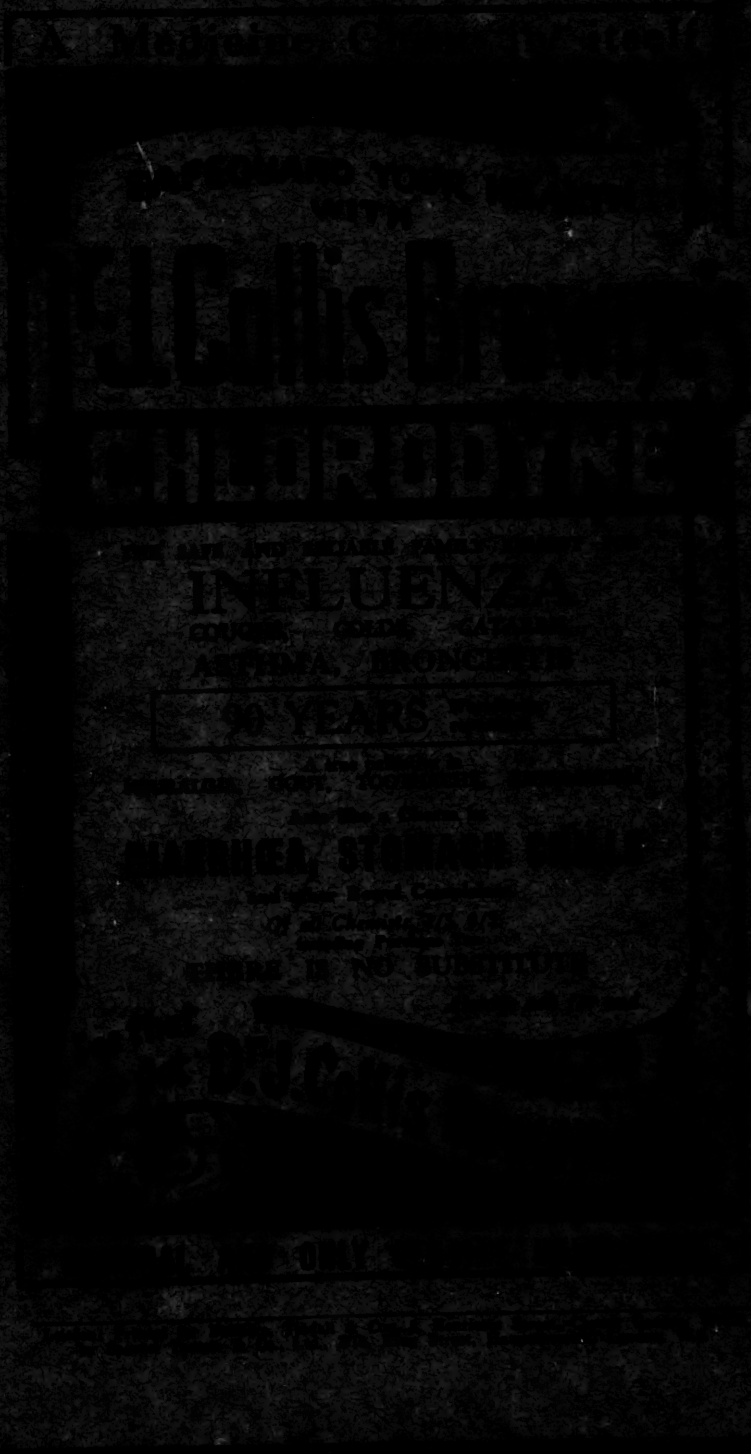

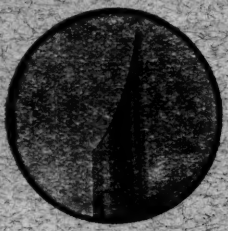

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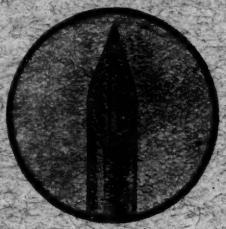

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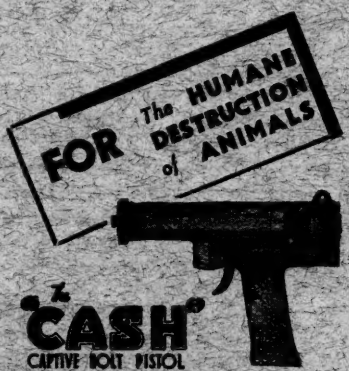

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